Miller and Walker Creeks Basin Plan

Executive Proposed – February 2006

Port of Seattle

BURIEN

CITY OF SEATAC

CITY OF NORMANDY PARK WASHINGTON

Washington State Department of Transportation

King County

Planning Process Participants

In December 2002, six agencies with jurisdiction in the Miller and Walker Creek Basins signed an Interlocal Agreement. The purpose of the agreement was to commit to resources and funding for this planning process. Part of this process included regular Executive Committee and Project Management Team (PMT) meetings.

Executive Committee

City of Burien
City of Normandy Park
City of SeaTac
King County
Port of Seattle
Washington State Department of Transportation

Project Management Team (PMT)

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Dan Bath, Engineer/Capital Project Manager

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Roger Kuykendall, Consulting Engineer

City of SeaTac
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Chapter One: Introduction

Walker Creek flows through urbanized areas

Our image of Washington State is a land of sparkling rivers, wetlands, lakes, and coastal waterways. Keeping these waterways clean is essential not only to the natural beauty and health of our communities, but also to the survival of fish and other species for which the waterways are habitat.

Two of these water features in the Central Puget Sound region, Miller Creek and Walker Creek, have become degraded as a result of surrounding urban development.

Where are the creeks located?

Miller Creek and Walker Creek are generally located just west of the Seattle Tacoma International Airport (Sea-Tac Airport). Miller Creek flows for roughly six miles through the urban area of Burien and adjacent communities. Walker Creek runs through a similarly developed landscape for about two miles. **Exhibit 1-1,** on the following page, identifies the general location of the creeks and their surrounding watersheds (the larger land area draining to the creeks). The cities of Burien, Normandy Park, and SeaTac, as well as King County, the Port of Seattle, and the Washington State Department of Transportation (WSDOT), all have land area and/or infrastructure within the Miller Creek and Walker Creek watersheds (referred to collectively henceforth as “Miller and Walker Creeks Basin” or “Basin”).

Because of the past degradation and continuing threat to the Creeks and their value to the community, Burien, SeaTac, Normandy Park, King County, the Port, and WSDOT have worked together to develop a basin plan for the Miller and Walker Creeks Basin.

How did the partnership develop?

Washington State requires cities such as Burien, Normandy Park, and SeaTac to meet current standards for protecting water quality within their

Exhibit 1-1
Vicinity Map: Miller and Walker Creeks

jurisdictions. The cities want to fulfill this responsibility and safeguard their streams. In addition, King County has a longstanding interest in developing a basin plan for the Miller and Walker Creeks Basin. The Port of Seattle and WSDOT are also large public property owners within the Basin and want to work cooperatively with local jurisdictions to assess problems and develop solutions for the Basin.

Discussions about a basin plan started ten years ago. Through the years, King County staff met with local jurisdictions to build support for development of the plan. In December 2002, an interlocal agreement

(ILA) (see **Appendix A**) among Burien, SeaTac, the Port of Seattle, the WSDOT, and King County became effective. The agreement committed the parties to preparing a basin plan. In addition, it provided an overview of the work to be included, set up a budget, and formed the Project Management Team (PMT), comprised of one representative from each of the signatories to the interlocal agreement.

Shortly after the start of this basin planning effort, the city of Normandy Park indicated its interest in taking part in the process; therefore, an amendment to the interlocal agreement was drafted that added Normandy Park as a participant and member of the PMT. The amendment became effective in July 2003. **Appendix A** contains this amendment.

How were planning activities managed?

Miller Creek upper watershed

Under the direction of the PMT, King County technical staff performed technical analyses and provided the information to produce the Basin Plan. King County's technical support to the PMT was a multidisciplinary effort involving geologists, ecologists, water quality scientists, hydrologic modelers, and engineers. The technical work performed by King County included literature reviews, field investigations, development of hydrologic models, and planning-level engineering analysis.

Did the PMT coordinate with other planning activities?

There are other ongoing planning efforts that include the Miller and Walker Creeks Basin, which is located in Watershed Resource Inventory Area[1] (WRIA) 9[2]. WRIA 9 planning and habitat work is being done in cooperation with citizens, scientists, businesses, and environmentalists.

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[1] *A WRIA is a term used by state, local planning, and resource agencies to refer to one of the state's 62 major drainage basins.*

[2] *WRIA 9 includes the Green/Duwamish and a portion of the Central Puget Sound watersheds.*

Coordination with WRIA 9 staff occurred during preparation of this Basin Plan. Although WRIA 9 efforts are more closely focused on chinook salmon,[3] the general recommendations are applicable to the Miller and Walker Creeks Basin. The Basin Plan is consistent with the more general WRIA 9 habitat protection and restoration goals, but provides additional detail designed to meet the specific needs of the Miller and Walker Creeks Basin.

Besides the WRIA 9 planning efforts, there have been many past studies of the Basin; a summary of these studies is included in **Appendix B**. Because none of these past studies developed basinwide hydrologic models,[4] development of the Miller and Walker Creeks Basin Plan is a critical step in protecting the Basin.

Is the public involved in this process?

As part of this basin planning process, community meetings were held in October 2003 and March 2004. Citizens heard presentations from King County technical staff concerning goals, existing conditions in the Basin, potential solutions to identified problems, and planning-level costs for potential capital projects and programs. Citizens were encouraged to ask questions and provide comments. A website for the project was also created.[5] The website features maps, project background, and technical information. The Basin Plan is readily available to interested citizens via the project website or by contacting any of the PMT members listed in the front of this document.

What is contained in the Basin Plan?

The Basin Plan:

- describes current Basin conditions;
- outlines regional surface water problems within the Basin; and
- gives recommendations to improve the Creeks' current condition and to protect them from the impacts of development.

Detailed technical analyses are not included in the main body of the Basin Plan. Appendices included in this document incorporate

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[3]*Chinook salmon have been listed as a threatened species under the Endangered Species Act (ESA) and have not historically occurred in Miller Creek or Walker Creek.*

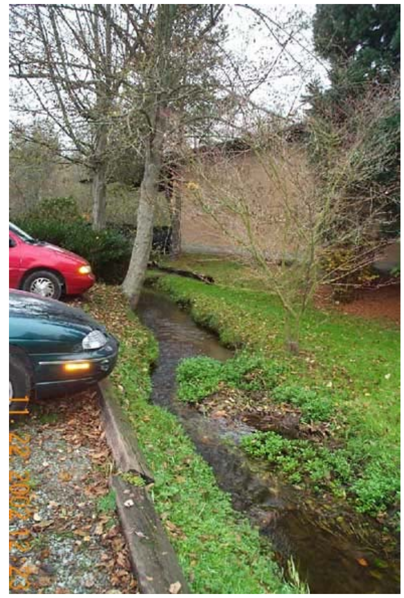
[4]*The Port of Seattle did an extensive hydrologic model of the Miller and Walker Creeks Basin as part of their permitting for the third runway project and other master plan projects. This modeling was done specifically for the Port facilities.*

[5]*http://dnr.metrokc.gov/wlr/watersheds/puget/miller-salmon/index.htm*

summaries of the technical information. For more detailed analyses, the supporting documentation to the Basin Plan should be consulted. For the average reader or decision-maker, this supporting documentation is not necessary to understand the Basin Plan and its recommendations.

Chapter Two: Purpose and Need for the Basin Plan

The Miller and Walker Creeks Basin has been and continues to be significantly affected by development. Based on past experience, observation, and study, it is probable that over the past several decades, the Basin has increasingly experienced degraded aquatic habitat, areas of flooding and erosion, and poor water quality. The need to address these issues has led the partner jurisdictions to recognize the need for the Basin Plan.



Walker Creek at the Normandy Park Community Club – showing degraded channel and lack of riparian vegetation

What is a basin plan?

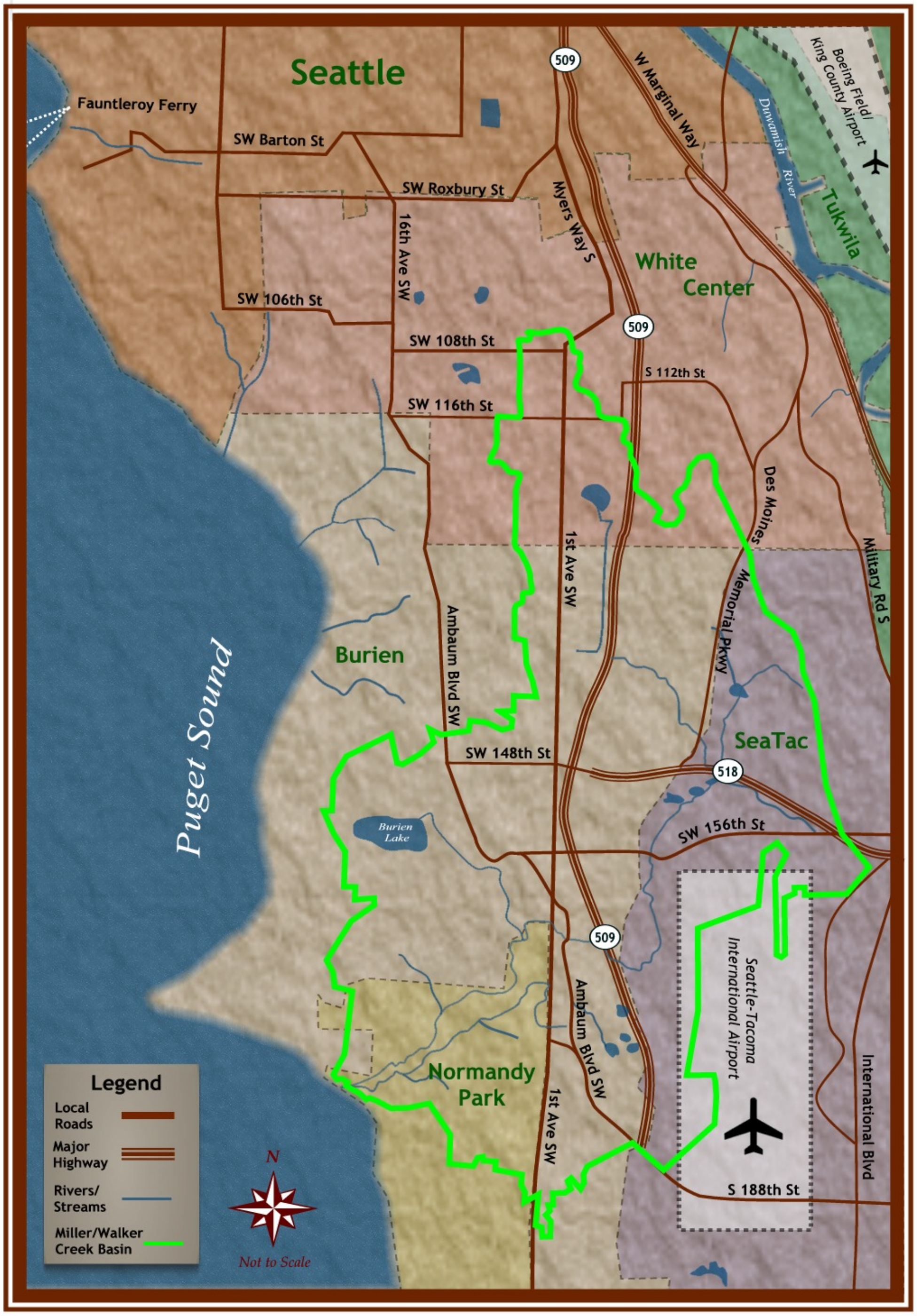
A basin plan identifies ways to address surface water management problems such as flooding, poor water quality, erosion, and aquatic habitat degradation, and outlines solutions to problems identified. Typically, only problems of a regional nature are considered in a basin plan.

The focus of such planning is a specific drainage basin -- a geographic area which drains into a specific waterway -- in this case, either Miller Creek or Walker Creek. Because these two creeks have a common estuary and affect the same communities, the Project Management Team felt it was appropriate to prepare a single basin plan for both.

What area does the Basin include?

The Miller and Walker Creeks Basin encompasses approximately eight square miles of land. It is bordered on the north by SW 108th Street, on the south by the northern boundary of the city of Des Moines, on the east by Sea-Tac Airport (and the area immediately north of it), and on the west by Puget Sound. **Exhibit 2-1**, on the following page, presents the location of this basin in relation to the surrounding communities.

Exhibit 2-1
General Location of the Miller and Walker Creeks Basin



Development within the Basin is a combination of residential neighborhoods and commercial uses. Scattered future residential and commercial development projects are planned, and the Port is constructing a third runway on the eastern edge of the Basin (where 12th Avenue South is currently located).

What is the purpose of the Miller and Walker Creeks Basin Plan?

The Basin Plan provides an overview of current characteristics of the Basin, identifies current and future problems, and provides recommendations to address these problems within a twenty-year planning horizon.

Basin planning recognizes that urban activities contribute to changes in the natural characteristics of watersheds that frequently threaten healthy watershed systems. The focus of basin plans has been on reducing flood damages, protecting stream and wetland habitats, and improving the quality of surface water and groundwater.

Flooding in Burien

The Basin Plan contains strategic recommendations to correct or reduce problems identified through the planning process. It also provides guidelines for future actions with the objective of improving overall conditions within the Basin. As with all natural systems, watersheds are comprised of relationships between land use, water quantity, water quality, and aquatic habitat. As a result of these relationships, activities in one part of the Basin influence, and in turn are influenced by, activities elsewhere. These relationships are particularly relevant to the consideration of proposed remedies to problems in the Basin.

Why is the Basin Plan needed?

Extensive flooding and erosion within the Basin have resulted in general impacts to the overall community, as well as to water quality and the natural habitat.

Development in the Basin has reduced forest cover, increased impervious surface area, and filled in wetlands. All of these changes have altered the area's natural runoff rate and duration. The amount of effective impervious area (as differentiated from the total impervious area) has increased to a basinwide average of about 22 percent under current conditions, including the yet-to-be-completed Sea-Tac Airport third runway. Without any changes in zoning or development protections, the amount of effective impervious surface is estimated to increase to 30 percent in the future.

Ambaum Pond flooding First Avenue South

Impervious surface is a term used to describe land or buildings which resist penetration by water. An impervious surface is typically that portion of a watershed, expressed as a percentage, that is covered by surfaces such as rooftops, parking lots, sidewalks, driveways, streets, and highways. Quantifying and evaluating impervious surfaces is important because they will not absorb rainfall and, therefore, cause almost all of the rainfall to appear as surface runoff (which in turn, could potentially harm the water quality of Miller and Walker Creeks).

The change from a predominantly forested basin to one with an increasing percentage of impervious surface has had significant hydrologic implications. Stormwater regulations have been in place for several decades and their implementation has mitigated the impact of increased impervious surface somewhat; however, as most of the Basin was developed prior to regulations urbanization has led to negative stormwater impacts throughout the Basin. Flood flows have increased, resulting in additional erosion, flooding, and sediment deposition.

Human activity in the Basin also has affected local water quality. Pollution from businesses, lawn care practices, and road and highway runoff have contributed to the degradation of Miller and Walker Creeks and their tributaries. In addition, reductions in base flow (flow that is spring-fed rather than runoff-fed) in streams and removal of riparian vegetation have increased water temperature.

Collectively, impacts associated with human activities have reduced the habitat value of local streams, which has reduced the capacity of the Miller and Walker Creeks system to support migratory and resident fish.

Because human land use in the Basin is expected to increase, these problems must be addressed to improve existing conditions and prevent further deterioration of watershed resources important to humans and native wildlife and plants.

How were these potential solutions identified?

It was apparent to PMT members that problems were occurring within the Basin. These problems, as presented above, triggered the need for a comprehensive analysis of the current and future conditions in the Basin.

Flooding along Burien streets

As part of this analysis, data on existing Basin conditions was gathered. This data, as detailed in the Appendices, includes inventories of water quality and geologic characteristics, data on water flows, and data on location/quality of natural habitat, that provided the foundation for analysis and modeling. In addition, current conditions also enabled the PMT to develop goals and objectives for the Basin. These goals and objectives provided the framework for identifying potential short-term and long-term solutions.

Chapter Three: Basin Characteristics and Analysis

This chapter:

- outlines the physical characteristics of the Miller and Walker Creeks Basin, including how the Creeks are situated in the surrounding community;
- describes the hydrologic, water quality, and habitat characteristics of Miller and Walker Creeks and the work performed through the Basin Plan to determine and analyze these characteristics; and
- specifies the Creeks' primary surface water-related problems in terms of hydrology, water quality and habitat and describes additional problems not currently attributable to any of these three areas.

The Basin at a Glance

Topography of Miller and Walker Creeks

The Miller Creek Basin encompasses the mainstem of Miller Creek, which begins north of Tub Lake in the City of SeaTac. A number of tributary streams, including one originating to Burien's north in unincorporated King County, join and add their flows to the mainstem as it winds its way generally southward. Lora Lake, Lake Reba, and seeps located on the west side of Sea-Tac Airport also contribute waters to Miller Creek. In addition, stormwater runoff from Hermes Depression, which does not naturally contribute water, is pumped into Miller Creek via a system of pipes and open channels.

From wetlands on Port of Seattle property south of South 160th Street, the mainstem turns generally westward then meanders to its discharge point into Puget Sound. This discharge point was once an estuary and is now on private property owned by the Normandy Park Community Club. The property was filled and developed approximately forty years ago. Lake Burien and a number of tributaries also contribute flows to this portion of Miller Creek.

A number of significant stormwater flow control facilities has been constructed along Miller Creek, including the Miller Creek Regional Detention Facility at Lake Reba and the Ambaum Regional Detention Facility at 1st Avenue South near the border between Burien and Normandy Park. These projects were constructed to help control flooding exacerbated by development that existed prior to stormwater regulations. Most runoff in the Basin is conveyed to the creeks via pipes and ditches and these flows are not detained (held to decrease the runoff rate).

Walker Creek begins in a wetland just east of Des Moines Memorial Drive South between South 171st Street and South 176th Street, just inside the City of SeaTac. It meanders generally westward through a series of wetlands and open water areas in the City of Burien. At 1st Avenue South it crosses into Normandy Park and continues generally westward where it joins Miller Creek before reaching its Puget Sound discharge point on the Normandy Park Community Club. The Creek has a few small north-flowing tributaries in Burien and Normandy Park; most of the area draining to the watershed is to the south of the Creek.

Unlike on Miller Creek, no stormwater flow control facilities have been constructed on Walker Creek, which has not experienced the type of development-related problems seen with Miller Creek. Development in the Walker Creek Basin has been generally less intense, and this Basin also has more absorptive soils.

Exhibits 3-1 and 3-2 show the locations of Miller and Walker Creeks, their tributaries, and other key water features in relation to the surrounding communities.

Land Use in the Basin and Its Impacts on the Creeks

The Miller and Walker Creeks Basin is home to about 30,000 people. Residential neighborhoods (mostly single family homes) comprise about 88% of the Basin's land parcels and 74% of its total land area. Commercial and industrial uses comprise most of the Basin's remaining land, with municipal and open space facilities scattered throughout.

The Port of Seattle completed the Seattle-Tacoma (Sea-Tac) International Airport, located in the Basin's eastern portion, in 1944. Through the decades, the airport has been expanded to accommodate increased volumes of air traffic and larger aircraft, and Port properties now account for about 17% of the land area in the Basin.

Two major highways are located within the Basin, in addition to numerous residential and arterial roadways. SR 509 passes through the Miller Creek Basin in a north-south direction, and SR 518 connects to SR 509 and heads east at about the mid-point of the Miller Creek portion of the Basin.

In total, the Basin contains approximately 156 miles of paved roads and highways. About 21%, or between one-fourth and one-fifth, of the Basin is now covered by impervious surface such as roads, buildings and parking lots. In addition, other types of groundcover that result from development, such as lawns, have varying degrees of perviousness and contribute significantly to stormwater runoff.

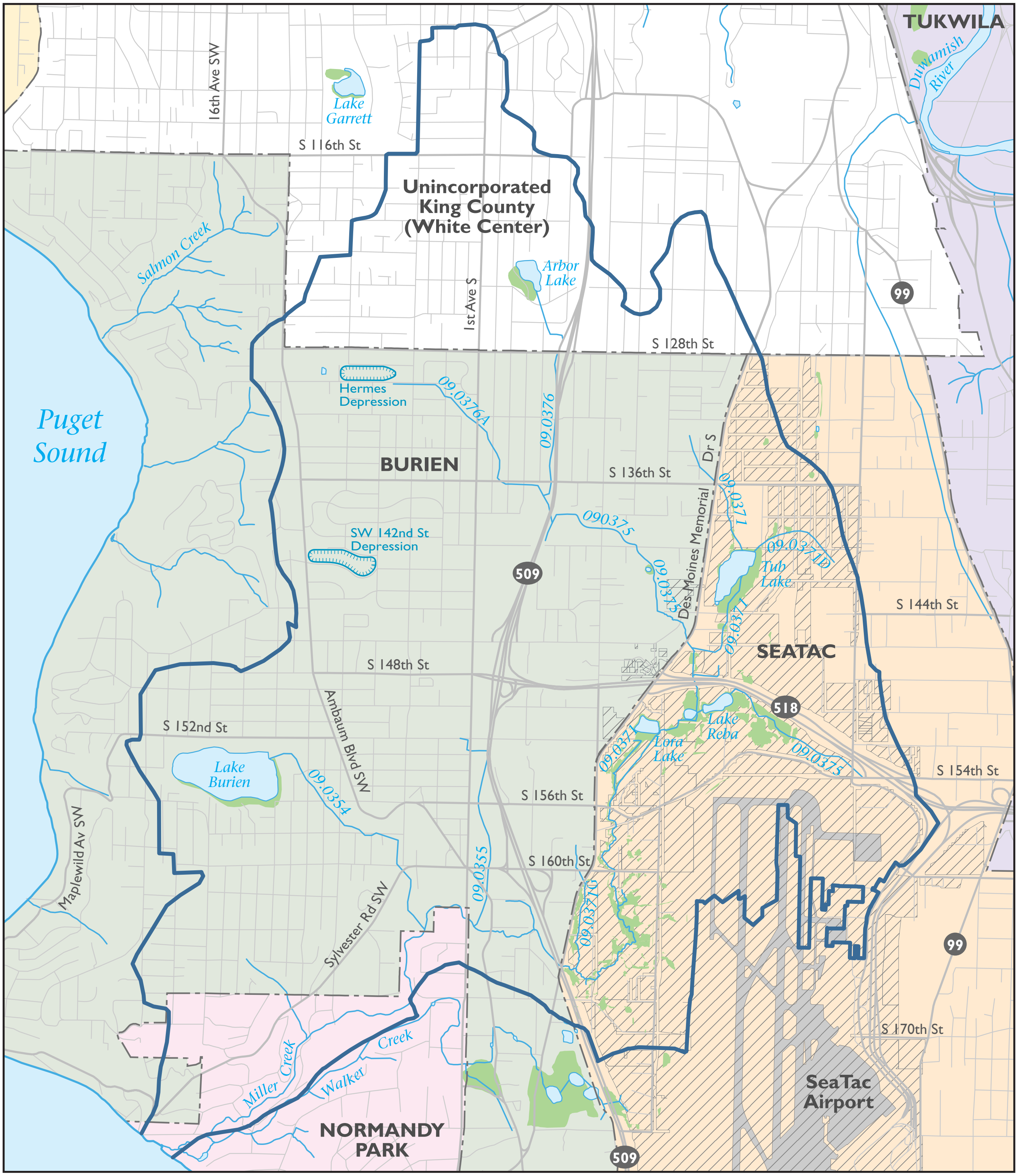


EXHIBIT 3-1

Miller Creek Basin

- Basin Boundary
- 090375 Stream/Tributary Number
- Lake/Open Water
- Wetland
- Depression
- Port of Seattle Owned Parcels

N

0 1/4 1/2 Mile

July 2005

King County

Department of Natural Resources and Park

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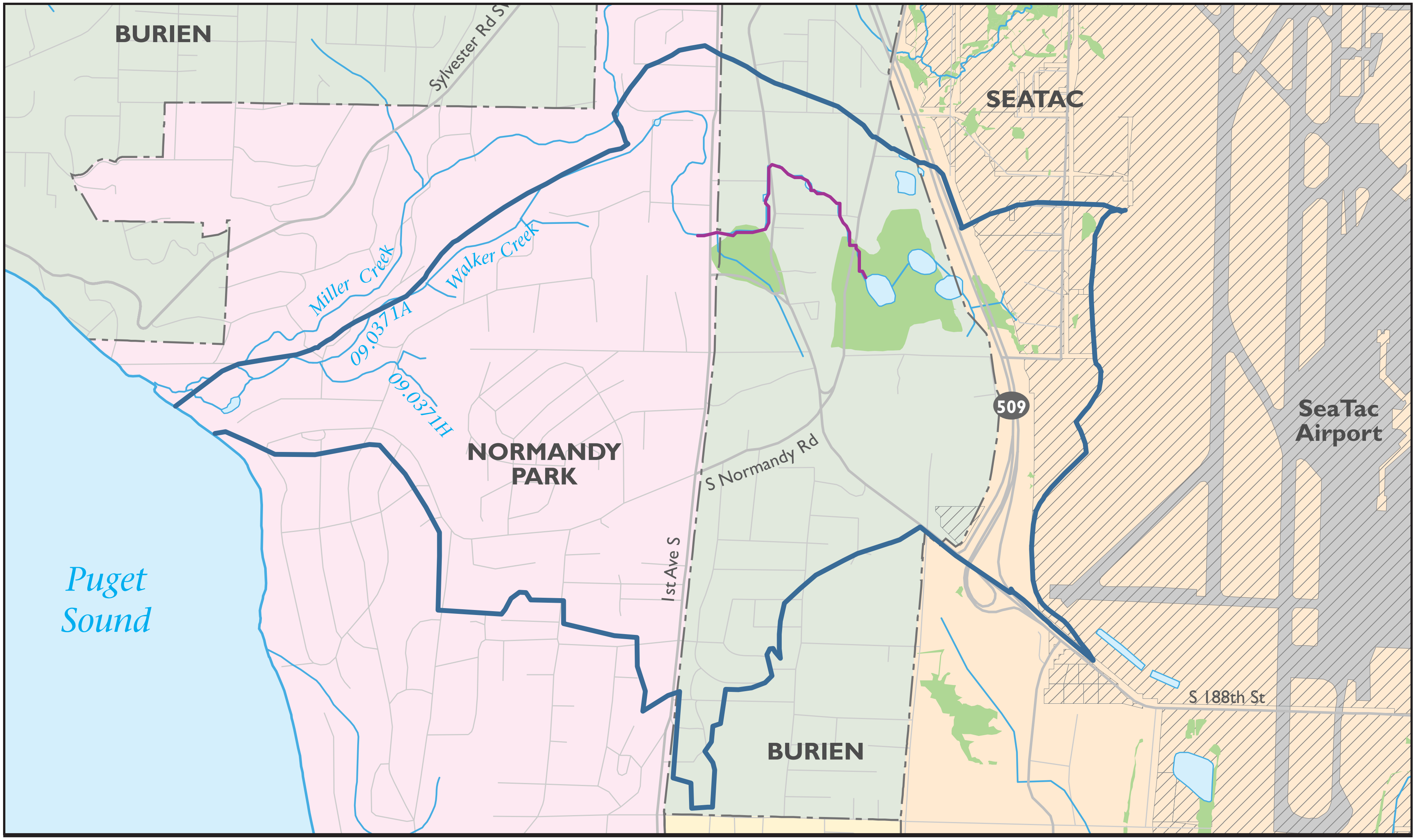

EXHIBIT 3-2

Walker Creek Basin

Basin Boundary
090375 Stream/Tributary Number
Lake/Open Water
Wetland
Port of Seattle Owned Parcels

N

0 1/4 1/2 Mile

July 2005

King County

Department of
Natural Resources and Parks

Map prepared by King County DNRP GIS and
WLR Visual Communications & Web Units
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A good illustration of the impacts to the creeks from development comes from looking at streamflow data at the mouth of Miller Creek. Under forested conditions, it is expected that six cubic feet of water per second would flow past the mouth during a one-year return period (storm flow from a rain event likely to occur on average once a year). Currently, storm flows at the mouth for the same type of rain event are at about 95 cubic feet per second, or about sixteen times higher than under forested conditions (please see **Appendix D** for more detailed information on flow analysis).

In addition, as discussed below, development has caused and continues to cause impacts to the water quality and stream habitat as well as stream flow.

Key Indicators of Watershed Health: Hydrology, Water Quality, and Habitat

To determine what surface water problems are occurring in a watershed and their actual or possible causes, the watershed must be evaluated from three important perspectives:

Hydrology – *How water flows in terms of quantity of water flowing, how quickly flows are moving, and the span of time over which flows, particularly high flows, are occurring*. For purposes of this Basin Plan, the key flows for analysis are stream flows in Miller and Walker Creeks. When flows are too high, too fast, or too extended in duration, they can cause problematic erosion and/or flooding.

Water Quality – *the degree to which surface waters contain pollutants that may compromise the health of humans and animals and the vegetation animals use for food and shelter*.

Habitat – *the features and characteristics of a water body that support its use by plants and animals as a place to live and grow*.

Hydrologic Analysis of the Miller and Walker Creeks Basin

To determine the stream flow characteristics of Miller and Walker Creeks (both under current conditions and given different scenarios such as less-developed and more-developed conditions), King County staff developed a hydrologic model for the Basin. The model was created with the computer program HSPF (Hydrologic Simulation Program – Fortran). Inputs to the model (parameters) were data regarding:

- Land cover (i.e. forest, impervious surface, type of development, etc.)
- Rainfall data (past 50 years)

- Drainage features such as ponds, lakes and wetlands (i.e. features that have the effect of slowing flows)

The hydrologic model provides two critical baselines for evaluating stream flow: the **fully forested** scenario, which shows what stream flows would be like if there were no development in the Basin, and the current scenario, which shows what stream flows are like now. The **current** scenario provides the best information on what hydrologic (flow-related) problems are occurring now, and the fully forested scenario shows essentially the best conditions that could have existed for the Miller and Walker Creeks Basin.

A third key scenario that the model allowed the PMT to evaluate was **future conditions**, in which flows were predicted given assumptions about land use changes. As detailed in **Appendix D**, the Basin Plan PMT reviewed numerous sources including comprehensive plans, zoning maps, and economic development plans in order to identify potential future developments within the partner jurisdictions. It was concluded that the amount of development possible under existing zoning (i.e., maximum build-out) was too high to provide a realistic estimate of hydrologic changes during the next twenty years. Instead, data on parcels identified as likely to develop or redevelop in the future were used as inputs to the hydrologic analysis for future conditions scenarios.

Among significant future land use changes utilized for the model were the Port of Seattle's third runway project, the City of Burien's Special Planning Area redevelopment, and the Washington State Department of Transportation's SR 518 highway improvement project.

The current scenario results from the model showed that the primary flow-related problem in the Basin is that current flows are too erosive for gravel beds to exist in the streams. Gravel beds are a critical element of salmon habitat; they are the only stream substrate (bottom surface) in which salmon can spawn, and also provide key habitat for the insects that salmon survive on. Further discussion of this problem is provided later in the chapter, and as discussed in Chapters Four and Five, the PMT used the current, forested and future stream flow scenarios to develop goals and actions for addressing the flow problems in the Basin.

The model results also showed that low flow levels in the streams were at acceptable levels as compared to forested conditions. Low streamflows generally occur in the summer; if flows are too low water temperatures can rise to levels that can be harmful to fish and fish are unable to gain access to habitat.

Water Quality Analysis of the Miller and Walker Creeks Basin

In order to establish how well water is able to support life forms living in water bodies and the degree to which components in the water may be harming organisms that live in it or come in contact with it, water quality analyses are performed. To evaluate the water quality in a watershed such as the Miller and Walker Creeks Basin, scientists may evaluate samples of stormwater runoff that ultimately enters water bodies and samples directly from the water bodies themselves.

A critical finding in studying water quality is levels of pollutants that may be detrimental to living things. Some key pollutants that may be found in stormwater runoff and water bodies are:

- Metals that may come from vehicles and/or structures (galvanized metal surfaces)
- Anti-freeze and petroleum-based pollutants coming from vehicles, roads and parking lots
- Detergents and solvents from a range of activities (such as individuals washing cars)
- Pesticides, herbicides and excess nutrients from lawn/garden care
- Excessive fecal coliform bacteria from pet waste and nuisance waterfowl
- Paints and other substances dumped illegally into storm drains

To evaluate water quality characteristics in the Basin, King County staff analyzed existing data from a number of water quality studies completed by other agencies and jurisdictions. Past analysis has indicated elevated levels of metals (zinc and copper), fecal coliform bacteria and pesticides discharging to Miller Creek.

The presence of fecal coliform indicates that water has come into contact with animal or human wastes and that disease pathogens may also be present. While fecal coliform does not represent a health concern for aquatic organisms, it is possible that humans coming into contact with the water could be adversely affected through the disease pathogens.

For a more detailed outline and discussion of water quality studies evaluated and findings, please refer to **Appendix F**.

All jurisdictions are responsible for meeting Washington State Surface Water Quality Standards, which set limits on pollutant levels in water bodies and set required levels for other water quality parameters such as dissolved oxygen and temperature. To meet requirements of the federal Clean Water Act, the State must periodically submit to the U.S. Environmental Protection Agency a statewide assessment of available water quality data, including a list of known polluted waters in the state (known as the 303(d) list – referring to the applicable section of the Clean Water Act.)

Pending federal confirmation, based on monitoring performed in 2004 by the Washington Department of Ecology (DOE), Miller Creek has been placed on the 303(d) list as not meeting water quality standards for fecal coliform (DOE, 2005). If confirmed, the listing will require that a Total

Maximum Daily Load (TMDL), or Water Cleanup Plan, be prepared by the state and implemented for the Miller Creek Basin. Basin jurisdictions will be required to implement the TMDL through their NPDES (National Pollutant Discharge Elimination System) Municipal Stormwater Permits, which require municipalities to control pollutant sources identified in the TMDL and implement a DIP (Detailed Implementation Plan) developed by DOE.

The upper reach of Miller Creek has also been listed as a "Water of Concern" (Clean Water Act Section 305(b) – known as a Category 2 listing) for copper and zinc (DOE, 2005). This listing indicates a potential problem and will require additional data to make further determinations on any required remediation.

Please refer to **Appendix F** for more detailed information regarding state and federal water quality standards applicable to the Basin.

Habitat Analysis of the Miller and Walker Creeks Basin

The Basin's natural habitats have changed dramatically over the past 100 years. Based on knowledge of land cover in the Puget Sound region, it is probable that the entirety of the Basin was forested except for water bodies and wetlands. It is also likely that under fully forested land cover, many more fish, amphibians, birds, and mammals inhabited the Basin than do at present. Annual spawning returns of one to two thousand chum, coho, steelhead, and cutthroat are estimated to have occurred before the effects of urbanization, an approximate ten-fold difference over recent returns (**Appendix C** provides information on estimates of lost fish productivity in the Basin.)

With urbanization of the Basin came filling of wetlands, straightening and channeling of streams, introduction of water pollutants, and replacement of forest cover with less pervious surfaces leading to higher flows and increased erosion. Over time, much of the Basin's habitat, and of particular interest for this Basin Plan its stream and streamside (riparian) habitat, was lost or degraded.

King County staff conducted field surveys to gather information on the quantity, quality and distribution of stream and streamside habitat in the Basin today. Permission to access Miller and Walker Creeks from private properties was requested of many property owners; approximately one-third of those contacted allowed access. Data from habitat surveys and analyses conducted by other agencies, as detailed in **Appendix C**, was also collected and used.

King County staff also developed a geologic characterization of the Basin by performing field investigations and reviewing maps and aerial photos, which provided additional information about habitat types and conditions and geologically related problems.

For purposes of the riparian habitat assessment, Miller Creek was divided into eleven reaches (or segments) and Walker Creek was divided into seven reaches. Specific information was also developed for each stream tributary and for lakes and wetlands. **Appendix C** details the assessment on a reach-by-reach basis.

In general, the assessment indicates that riparian habitat in the Basin is compromised by the following factors:

Lack of buffer areas. Riparian buffers (native vegetated areas alongside streams) perform a number of vital functions for streams in urbanized areas: they attenuate stormwater flows into the streams, provide shade and cooler water temperatures, stabilize streambanks and filter out nutrients, chemicals and sediments, and contribute leaves, branches and terrestrial insects that feed the aquatic invertebrates that salmon eat.

Lack of large woody debris (LWD) and pool habitat. Riparian buffers are also the source of LWD (i.e. trees, large branches, etc.) for streams. LWD traps spawning gravels, houses aquatic organisms, and perhaps most importantly plays a key role in forming pools in streams, which are vital to salmon and other fish for spawning, rearing, feeding, resting, and finding refuge during high and low flow times.

High flows and erosion have damaged the stream bed. Analysis indicates that stormwater runoff and stream flows have lessened somewhat from past times (prior to stormwater control and land development regulations), but significant damage from past high flows (deposits of sediment carried in by stormwater, scouring away of fish-friendly streambed materials such as gravels) still remains. Conditions will not begin to improve unless high flows and erosion are further reduced.

Stream corridor alterations. In many areas the stream corridor has been altered to accommodate human needs. Such alterations include straightening of the stream channel, building structures on the banks, and constraining the stream in pipes or culverts. These actions have the effect of degrading habitat and/or creating barriers to fish passage from one section of stream to another.

The Big Picture: Surface Water-Related Problems in the Basin

Looking at the hydrologic, water quality, and habitat-related information described above allowed the PMT to start developing an overall picture of surface water-related problems in the Basin.

Flow-related Problems

Analysis shows that the major hydrologic problem in the Basin is that flows in the creeks are too erosive to allow the existence of a salmonidfriendly streambed. Specifically, the quantity of stormwater runoff entering the streams creates flows that are high enough to cause erosion that prevents the gravels that salmon need to live from accumulating on the streambed (recall from earlier in this chapter that storm flows at the mouth of Miller Creek for a one-year return rain event are estimated at sixteen times higher than under forested conditions).

Another perspective on the magnitude of the erosive power of flows in the creeks is through the concept of *erosive work*. For purposes of hydrologic analysis, it is assumed that below a specific flow threshold (one-half of the two-year peak flow forested conditions) little streambed erosion is occurring, i.e. the "bed load" is moving relatively little and the streambed is relatively stable. With flows above that threshold, flows are carrying the bed load away, and erosive work is calculated as the amount of time that the threshold is exceeded under various scenarios, i.e. forested, current conditions, etc. King County staff calculated for Miller Creek that under current conditions, erosive work is 400% greater at the mouth than it would be under forested conditions. It is also projected that if no new flow control measures are undertaken ("no mitigation" scenario) the percentage rises to 600%. For Walker Creek, the same analysis shows that under the "no mitigation" scenario erosive work is 60% greater at the mouth than the forested scenario and 30% for current conditions.

Flows have scoured the streambed to the extent that they have essentially dug it deeper than it would be under less-developed conditions (this is known as "downcutting"). This deepening has meant in part that the stream conveys more flows than it otherwise would, lessening mainstem flooding. Flooding has also been addressed through capital facilities such as detention ponds, and much of the creek is in a deep ravine which minimizes the human impacts of flooding. The only significant flooding related to creek flows now occurs in the vicinity of the Ambaum Regional Detention Pond and 1st Avenue South, directly south of the Pond.

Water Quality

Past water quality analyses performed on Miller Creek indicated elevated levels of metals. Metals and pesticides are toxic to fish and other wildlife living in the stream (although it is not known specifically what toxic effects occur at what levels), and fecal coliform may indicate a health hazard for humans coming into contact with water in Miller Creek. Based on data gathered in 2004, Miller Creek Basin jurisdictions are out of compliance with state water quality requirements with regard to fecal coliform levels found in the Creek. Pending federal confirmation, Miller Creek jurisdictions will be required to implement Water Cleanup Plans as part of their NPDES Municipal Stormwater Permits (please see **Appendix F** under "Federal and State Water Quality Standards" for specifics regarding the requirements of Water Cleanup Plans/TMDLs).

Additional monitoring may result in jurisdictions being out of compliance additionally for zinc and copper in the upper reaches of Miller Creek, with additional cleanup actions being required.

Habitat Problems

Earlier in this chapter, the following factors were discussed as characterizing the habitat problems in the Basin:

- **Lack of buffer areas (**lack of native-vegetated areas adjacent to the Creeks)
- **Lack of large woody debris and pool habitat** (the Creeks lack logs and other large debris from vegetation that create vital habitat features)
- **Stream corridor alterations** (human alteration of the Creeks and their banks have degraded the streams' habitat value)
- **High flows and erosion have damaged the stream bed.** This is essentially the same problem identified as the primary flow-related issue in the Basin. From the habitat perspective, the streambeds in the Creeks consist primarily of larger stones and hardened till (underlying soil) – not the finer gravels and other materials that salmon need to survive.

Additional Concerns Not Specifically Attributed to Hydrology, Water Quality or Habitat

Several other concerns that do not necessarily fall into one of the above three areas of study give additional perspective on the health of the Creeks:

Pre-Spawn Mortality. In 1999, an assessment of spawning and habitat in three Puget Sound streams found, through examination of carcasses, that spawning coho salmon in Miller Creek had voided (laid) only about 28% of their eggs and spawning salmon in Walker Creek had voided only 37% of their eggs. This means that the salmon had died before most of their eggs were laid. A steelhead carcass in Walker Creek had voided no eggs; chum salmon carcasses in both creeks were completely voided of eggs.

In 2002, the Northwest Fisheries Sciences Center (part of the National Oceanic and Atmospheric Administration) initiated further research into pre-spawn mortality and its cause. A very high pre-spawn mortality rate in coho was found in Longfellow Creek, a highly urbanized basin just north of the Miller Creek Basin. A primary focus of causation is stormwater quality, although no definitive links have been established. Please refer to **Appendix F** for additional information on pre-spawn mortality and water quality.

B-IBI Score. "B-IBI" stands for *benthic index of biological integrity*. Benthic invertebrates are small creatures living in streams that because of specific attributes can function as barometers of a stream's general biological health. Some of these invertebrates are much more sensitive to degrading factors in streams (e.g. pollutants and high flows) than others. If a stream contains relatively more of the less-sensitive invertebrates than the sensitive ones, its B-IBI score is lower. A minimally degraded reference stream with excellent biological conditions will have a B-IBI score in the 45-50 range. Two studies, one performed in 2000 (Morley) and one performed in 2004 (Parametrix) found B-IBI scores of 12 and 14 respectively for Miller Creek, indicating poor biological health.

While the pre-spawn mortality and low B-IBI scores cannot yet be attributed to stormwater quality problems or other specific cause, they show that fish and other aquatic species are having trouble surviving in Miller and Walker Creeks as a result of a hydrological, water quality or habitat-related problem (or a combination thereof) in the Basin. Additional future study may shed more light on which factors are implicated, allowing decision-makers to refine actions to address problems in the Basin.

The pre-spawn mortality and B-IBI work also underscore the point that specific actions such as habitat restoration may not in isolation improve the viability of salmon populations; for example, if it were to be shown in the future that the pre-spawn mortality is positively linked to pollutants in stormwater, restoring habitat without ever addressing the pollutant problem might do little to increase the salmon population.

In Conclusion

The streambed in its current state provides poor salmon habitat in most of the Miller and Walker Creeks Basin. Until the high flows that lead to this problem are addressed, actions to address the other habitat-related problems in the basin are unlikely to lead to an increase in the salmon population, but taking advantage of opportunities to preserve existing pockets of high quality habitat should be a high priority.

While past analysis has shown that Miller Creek may experience elevated levels of pollutants such as metals and fecal coliform, the Basin jurisdictions are, as of August 2005, out of compliance with state and federal water quality regulations for a specific pollutant (fecal coliform) and specific cleanup actions will be required, with the possibility for future cleanup requirements for additional pollutants (as of August 2005, zinc and copper).

Data-gathering and study work performed by other agencies give additional indications that salmon are not surviving well in the Creeks and that the Creeks have poor biological conditions. Additional study and monitoring may help conclude whether these problems are related to hydrology, water quality, other habitat conditions, or all three. Actions taken to improve Basin conditions may need to be altered or prioritized according to future insight into problem causes.

Based on the Basin Plan work as a whole and these overall conclusions, the PMT developed Basin Plan goals, objectives and actions as outlined in the following chapters.

Chapter Four: Goals and Objectives

After reviewing existing Miller and Walker Creeks Basin conditions and modeling existing and future hydrologic characteristics, the PMT identified potential areas of concern. Based on this information, goals and objectives to maintain and/or improve the Basin were developed. This chapter presents these goals and discusses specific objectives.

One of the challenges in establishing goals for environmental protection and improvement is to ensure that the goals are realistic and practical. It is clearly not possible to develop a basin to a fully urbanized state over a number of decades, as is the case in this Basin, without having significant environmental impacts, but it is generally considered desirable to protect and enhance the environment. So in developing goals, it is a matter of deciding what level of impact is acceptable given the limits of engineering to improve conditions and the willingness to enact more protective regulations and fund capital improvements and programs.

Given these considerations, the underlying factor that helped guide the development of Basin goals was to restore lost habitat and water quality.

In this context, the PMT chose goals that are readily achievable utilizing the existing regulatory framework and that will improve the Miller and Walker Creeks Basin within the next twenty years. Estimates of costs to achieve the goals have also been developed.

What goals were established for the Basin?

After the technical analyses were completed, the PMT identified three categories for which goals needed to be established. These categories were selected based upon the analyses and modeling performed through this planning process. These categories, as discussed in Chapter Three, are:

- hydrology;
- water quality; and
- habitat.

Goals were then developed for each of these categories, based on existing and anticipated future conditions within the Basin. A discussion of these goals is presented below.

GOAL 1: High flow and erosion reduction

Reduce current high flows and associated erosion in the Basin to a level that allows for protection and restoration of stream characteristics necessary to support fish use. These flow reductions will also decrease any current flooding or hazardous erosion risk.

Meeting this goal will ensure that Miller and Walker Creeks have controlled flows during times of precipitation. Currently, because of high flows within the Basin (resulting from the amount of development and impervious surface in the watershed) heavy rains often result in flooding, hazardous erosion, and destruction of habitat.

It is not the intention of the PMT to return Miller and Walker Creeks to their original, undeveloped conditions. The goal is to reduce the current high flows and their associated erosion to more closely approximate the flows expected from a lesser degree of development in the Basin. Such flows would be more supportive of fish habitat.

Monitoring data will be needed to verify progress toward meeting this goal.

Goal 2: Water quality improvement

Improve existing water quality by reducing pollutants in stormwater runoff. Fulfillment of this goal will reduce the discharge of pollutants to the maximum extent practicable, which complies with current Clean Water Act[1] requirements for municipal stormwater.

Increased urbanization decreases water quality. Runoff (due to extensive impervious surfaces) into Miller and Walker Creeks and other waterways carries pollutants from cars, industry, and daily human activities.

Although there are limited water quality data available for the Miller and Walker Creeks Basin, past data have shown that a number of pollutants occur at elevated levels. The pollutants include excess nutrients, such as phosphorus; petroleum hydrocarbons; metals; and fecal coliform bacteria. These pollutants would either not be present in undeveloped (i.e., fully forested) conditions, or would be present in greatly reduced quantities. The effects of these elevated pollutant concentrations are not fully known; however, there is concern that adverse environmental impacts could occur.

The water quality improvement goal is a long-term goal and will not be achieved in just a few years. In all likelihood, several decades will be required to achieve this goal, given existing treatment technologies and current patterns of development and human behavior (e.g. societal preference for automobiles and manicured lawns).

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[1]Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. The Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States. It also gives the U.S. Environmental Protection Agency (EPA) the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continues to set water quality standards for all contaminants in surface waters.

Monitoring data will be needed to optimize improvement efforts and verify progress toward meeting this goal.

Goal 3: Habitat protection and improvement

Protect existing areas of high quality habitat. Improve degraded habitat by reestablishing finer-grained gravels in the stream bed, thereby allowing formation of in-stream food sources and spawning areas, improving riparian areas, and restoring the most important areas of habitat.

Development in the Basin has greatly reduced the habitat available to fish, amphibians, birds, other animals, and vegetation, relative to pre-development (fully forested) levels. Although some habitat still remains within the Basin, the remaining high value habitat is located in isolated areas. Because it is always more effective to preserve habitat than try to recreate it, these high value areas should be protected.

Monitoring will be necessary to determine if the goal is being met.

How can these goals be achieved?

It is important to recognize that the three Basin goals are interrelated. It is not possible to protect and improve the habitat in the Basin without reducing high flows and erosion and improving water quality. There is value, however, in separating different aspects of the Basin (hydrology, water quality, habitat) in goal-setting so that more specific objectives can be identified and implemented. To apply the goals of the Basin Plan, further specificity was needed; therefore, objectives were developed in support of the goals.

Objective 1: High flow and Erosion Reduction

For the high flow and erosion reduction goal, it was necessary to further define the degree to which flows should be reduced. The following high flow and erosion reduction management objective was defined:

Reduce current high flows and their associated erosion to more closely approximate the high flows expected under a land coverage of 75 percent forest, 15 percent grass, and ten percent impervious area.

The ten percent impervious land coverage threshold has been shown in numerous studies (e.g., Booth and Jackson, 1997; Walsh, 2000; Wang et al., 2003) to be within a range of impervious coverage at which a stream can continue to function in a stable manner and retain some habitat functions. The ten percent threshold recognizes the fully urbanized nature of the Basin. Selection of this threshold is intended to reduce high flows and erosion so that flows are restored to a level similar to that existing prior to extensive development, but not what existed under fully forested conditions).

Objective 2: Water Quality

The following water quality objective was established in order to provide a quantitative measurement for achieving the water quality goal.

In highly developed areas where metal pollution is determined to exceed water quality criteria, work towards achieving fifty percent removal of total zinc and eighty percent removal of total suspended solids. In less intensively developed areas where water quality criteria for metals are being met, but water quality criteria for other pollutants are exceeded, work towards achieving eighty percent removal of total suspended solids.

These levels of proposed water quality treatment in polluted areas represent the treatment capability that can be achieved using treatment technology currently available. Note that no conventional treatment technology is completely effective and, therefore, the treatment effectiveness is always less than 100 percent. This underscores the fact that the most effective water quality measure is pollution prevention.

Objective 3: Habitat Management

For the habitat goal, specific numeric targets were chosen that will allow evaluation of progress towards meeting this goal. The following habitat objective was selected:

Fulfillment of the habitat goal should result in an increase in anadromous fish usage from its current level of approximately 200 returning spawners per year to as high a level as possible.

Based on pristine conditions, it was estimated that the Basin could support as many as 2,000 spawners each year.[2] Increases in fish usage should be measured using this pristine condition level as a goal.

This objective is dependent not only on what is done in the Miller and Walker Creeks Basin, but also on what occurs in Puget Sound and the Pacific Ocean. The potential for success in meeting this objective is ultimately dependent on factors beyond the direct control of the jurisdictions in the Basin. Those factors include the impacts of global climate change, El Niño conditions, ocean fishing, and pollution in Puget Sound and the Pacific Ocean.

To track the progress of increased fish habitat, water quality and temperature could be monitored. By relating these conditions to the potential for increased fish habitat, an approximation can be made regarding potential increases.

Another factor that must be considered is the proximity of Sea-Tac Airport to the Basin. Enhancing safe air carrier operations is a responsibility of the Port of Seattle. Accomplishing safe operations

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[2]*The desired increase in the number of fish returning to spawn in the basin is based on a comparison of the potential habitat versus the existing habitat (see **Appendix C**).*

entails careful monitoring of all aspects of arriving and departing aircraft in the airport vicinity, including potential wildlife hazards on and around the airport. The project partners recognize the Port's responsibility [per Federal Aviation Administration (FAA) guidelines] to minimize wildlife attractants in the immediate area of the airfield. The Basin Plan partners will work cooperatively with the Port to address these issues.

Chapter Five: Recommendations

In order to meet the goals and objectives for the Miller and Walker Creeks Basin, a range of actions will need to be taken. The specific actions will be implemented based on decisions made by the elected or appointed officials of the participating agencies. This plan presents several options for achieving the three Basin goals and objectives presented in Chapter Four.

The options presented below contain different types of actions and improvements and discussion of estimated total costs, their ability to achieve project goals, and their reliance on participation from property owners. The cost estimates are planning level (2004) ESTIMATES ONLY. Prior to actual construction, additional, more rigorous, design will be completed to verify the scope and costs listed for the respective projects.

In addition to the options presented in this chapter, a number of other options were considered during the planning process. Through extensive discussion among PMT members, and additional research, the majority of these alternative options were eliminated. **Appendix H** discusses and lists the alternative options for the Miller Creek Basin (which were developed as part of this process). **Appendix I** discusses and lists the alternative options considered for the Walker Creek Basin.

The PMT identified two types of recommendations: programs/regulations and capital projects. Each proposal was identified to achieve the three goals of the Basin Plan.

Programs and Regulations

1. Stormwater Flow Control Regulations

Goal 1: High flow and erosion reduction

Objective 1: *Reduce current high flows and their associated erosion to more closely approximate the high flows expected under a land coverage of 75 percent forest, 15 percent grass, and ten percent impervious area.*

All jurisdictions within the Miller and Walker Creeks Basin should work with the Washington Department of Ecology to secure approval for a Level 2 (75/15/10) detention standard for new development and redevelopment projects meeting the development thresholds identified in Ecology's *2005 Stormwater Management Manual for Western Washington* (or other equivalent standards) and for WSDOT projects meeting the improvement thresholds identified in the Ecology-approved *Highway Runoff Manual*.

This Level 2 flow control standard requires maintaining the durations of high flows at the pre-development levels for all flows greater than one half of the two-year peak flow up to the fifty-year peak flow. This Level 2 standard would be applied to developments assuming a pre-development site land cover of 75 percent forest, 15 percent grass, and 10 percent impervious surface.

Estimated cost:
Program development cost is negligible, although there is some cost to prepare and adopt ordinances for the new standards. Project development costs will be reduced relative to the standard Ecology requirement for Level 2 (Forest) detention.

Note: In 2006, WSDOT plans to initiate additional technical study to confirm the appropriateness of the 75/15/10 standard as described above. Results of such study will be evaluated by the PMT to determine if any changes to the detention standard are recommended for future revision to the Basin Plan.

2. Stormwater Water Quality Regulations

Goal 2: Water quality improvement

Objective 2: *In highly developed areas where metal pollution is determined to exceed water quality criteria, work towards achieving fifty percent removal of total zinc and eighty percent removal of total suspected solids. In less intensively developed areas where water quality criteria for metals are being met, but water quality criteria for other pollutants are exceeded, work towards achieving eighty percent removal of total suspended solids.*

All jurisdictions within the Miller and Walker Creeks Basin should adopt Ecology's *Stormwater Management Manual for Western Washington* or an equivalent manual and implement the water quality best management practices and treatment regulations for development and redevelopment projects meeting the development thresholds identified. WSDOT will use its adopted *Highway Runoff Manual* which provides guidelines and regulations regarding stormwater quality.

Estimated cost:
Program development cost is negligible, although there is some cost to prepare and adopt ordinances for the new standards. Project development costs will likely increase when implementing the new requirements.

3. Low Impact Development

Goal 1: High flow and erosion reduction

Objective 1: *Reduce current high flows and their associated erosion to more closely approximate the high flows expected under a land coverage of 75 percent forest, 15 percent grass, and ten percent impervious area.*

Goal 2: Water quality improvement

Objective 2: *In highly developed areas where metal pollution is determined to exceed water quality criteria, work towards achieving fifty percent removal of total zinc and eighty percent removal of total suspected solids. In less intensively developed areas where water quality criteria for metals are being met, but water quality criteria for other pollutants are exceeded, work towards achieving eighty percent removal of total suspended solids.*

Low impact development (LID) is a stormwater management strategy that emphasizes conservation and use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial, and industrial settings. Because the controls emphasize retention and infiltration of stormwater, they also benefit water quality. All jurisdictions in the Basin should, to the extent practicable:

- implement and monitor demonstration projects;
- develop regulatory guidance for LID practices; and
- remove regulatory barriers that discourage the use of LID strategies.

Estimated cost:
Program development cost is negligible, although there is some cost to prepare and adopt ordinances for the new standards. Costs for individual projects will vary, but are not necessarily more expensive than traditional development.

4. Conservation Easements

Goal 3: Habitat Protection and Improvement

Objective 3: *Fulfillment of the habitat goal should result in an increase in anadromous fish usage from its current level of approximately 200 returning spawners per year to as high a level as possible.*

Jurisdictions in the Basin should purchase conservation easements and streamside properties when opportunities and funding are available.

Estimated cost:
Unknown. Costs will vary on a property-by-property basis.

5. Basin Monitoring

All goals and objectives

An ongoing basin monitoring program should be initiated that will allow for trend analysis of flow, water quality, and habitat data. The flow data to be collected should include precipitation and stream gauge information sufficient to assess trends in high and low flows and erosive work, and to evaluate the effectiveness of capital projects and regulations. Water quality data to be collected should include data sufficient to conduct trend analysis of conventional water quality parameters, including hardness and temperature; metals; nutrients; and organics. Habitat data to be collected should include spawner surveys and B-IBI data[1] sufficient to determine biological trends in the Basin. Specific parameters to be measured, sampling locations, and sampling frequencies will need to be more fully developed as part of a sampling and analysis plan. Automated sampling should be used to the extent practicable.

Estimated cost:
$50,000 annual combined cost for both Miller Creek and Walker Creek.

6. Basin Stewardship

All goals and objectives

An ongoing basin stewardship program should be developed that will provide a single point of contact for activities and data relevant to the Basin. The steward should:

- Help citizens and jurisdictions coordinate, plan, and implement activities that will improve flow characteristics, water quality, and habitat in the Basin;
- Develop invasive weed removal, native plant salvage, re-vegetation, and other habitat improvement projects that directly involve citizen assistance;
- Manage and participate in Basin monitoring;
- Develop a website containing monitoring information and public education and outreach information, including water quality education information; and

[1]Benthic Index of Biotic Integrity (B-IBI) establishes whether the habitat in question can sustain life. B-IBI compiles a number of measures into a single score of benthic community health. Included in calculating the B-IBI are measures of species diversity, species composition, productivity, and trophic composition (Ranasinghe et al. 1997).

- Participate in school education programs and volunteer activities.

Estimated cost:
$50,000 annual combined cost for the Miller and Walker Creeks Basin.

7. Walker Creek Headwater Wetland Purchase and Protection Activities

Goal 3: Habitat Protection and Improvement

Objective 3: *Fulfillment of the habitat goal should result in an increase in anadromous fish usage from its current level of approximately 200 returning spawners per year to as high a level as possible.*

Purchase of this property, which will be owned by the City of Burien, is currently in process. After purchase, the following activities should be funded: improved mapping and delineation of the wetland, exploration of whether or not existing water quality regulations for surrounding properties are sufficient to protect it, invasive weed removal, and native planting. Some of these projects could be coordinated as public involvement activities.

Estimated cost:
$50,000 for protection activities – purchase costs are separate and total about $425,000.

Capital Facilities

Exhibit 5-1 shows the general location of these facilities.

8. Miller Creek Detention Facilities

Goal 1: High flow and erosion reduction

Objective 1: *Reduce current high flows and their associated erosion to more closely approximate the high flows expected under a land coverage of 75 percent forest, 15 percent grass, and ten percent impervious area.*

Additional detention – up to about 65 acre-feet (ac-ft)[2] - should be provided in the Miller Creek Basin. Three detention projects could be pursued to achieve this needed detention – expansion of the Miller Creek Regional Detention Facility by 40 ac-ft, expansion of the Ambaum Regional Detention Pond by 12.5 ac-ft, and purchase of

[2]*Units of water commonly are measured in acre-feet. An acre-foot of water, about 326,000 gallons,*

the City Light property and development of a detention facility of 12 ac-ft.

Estimated cost:

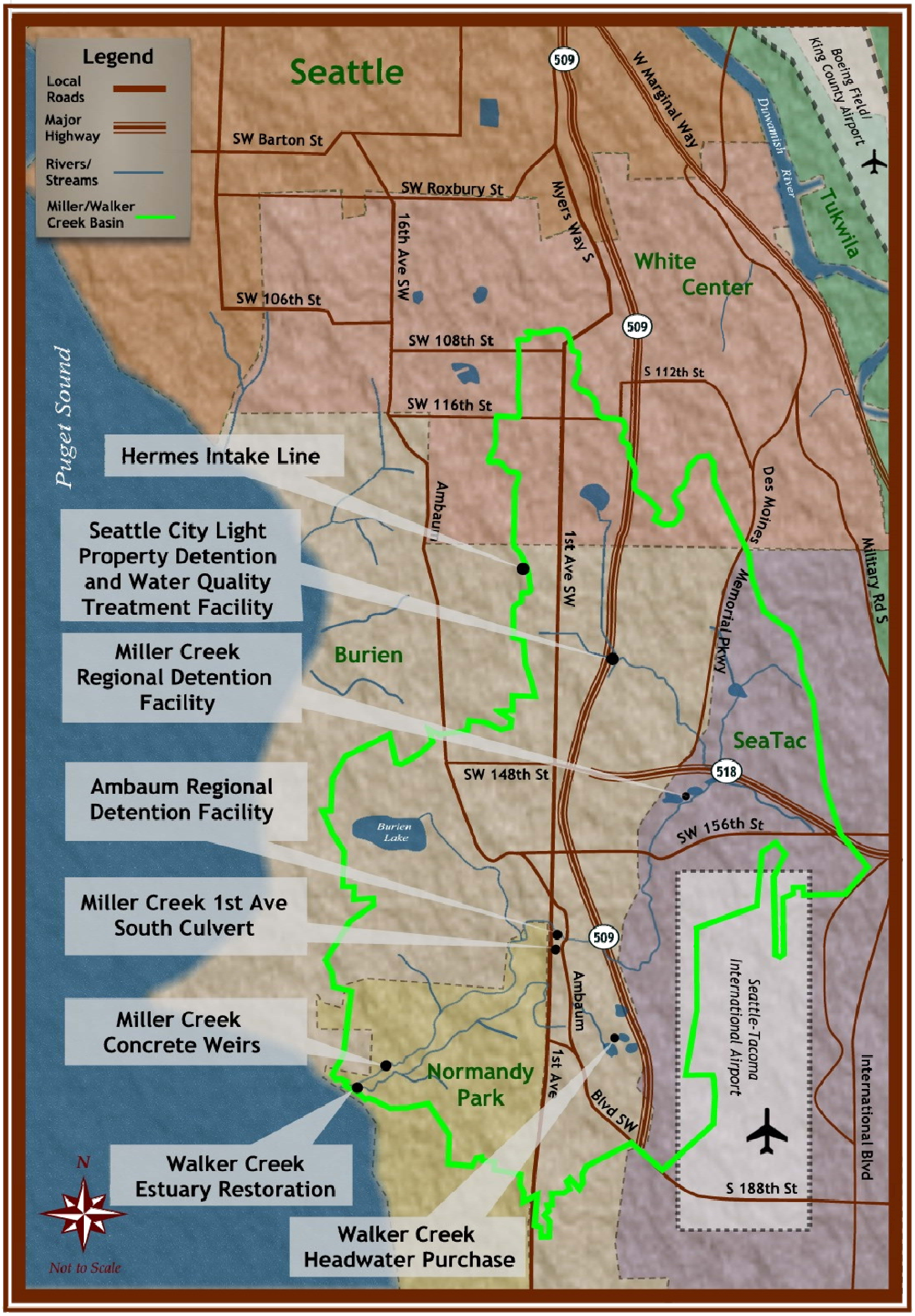
Miller Creek: $3.8 million to $10.3 million

Ambaum Pond: $1.4 million

City Light Property: $1.2 million

All costs depend on design requirements to address FAA bird strike concerns near the airport, and road and wetland impacts.

Exhibit 5-1
Location of Proposed Capital Projects



9. Miller Creek and Walker Creek water quality projects and retrofits

Goal 2: Water quality improvement

Objective 2: *In highly developed areas where metal pollution are determined to exceed water quality criteria, work towards achieving fifty percent removal of total zinc and eighty percent removal of total suspected solids. In less intensively developed areas where water quality criteria for metals are being met, but water quality criteria for other pollutants are exceeded, work towards achieving eighty percent removal of total suspended solids.*

The following water quality treatment projects should be pursued:

- Hermes Depression intake line modification;
- Ambaum Regional Detention Pond treatment (in coordination with expansion of the detention);
- Removal of Miller Creek from the asphalt ditch along SR 509; and
- The City Light property treatment facility (in coordination with detention facility construction).

In addition, water quality retrofits for existing development (e.g., coating of guardrails, neighborhood treatment facilities) should be evaluated.

Estimated cost:
Approximately $1,850,000; cost depends on the type of treatment needed and the extent and type of retrofit projects pursued.

10. Habitat restoration

Goal 3: Habitat Protection and Improvement

Objective 3: *Fulfillment of the habitat goal should result in an increase in anadromous fish usage from its current level of approximately 200 returning spawners per year to as high a level as possible.*

Restoration efforts should focus on changes in stream structure – specifically, reestablishment of finer-grained gravels in the stream bed. These gravels serve as habitat for insects that salmon eat. In addition, salmon use gravel for their redds or nests. Restoration of habitat could also be provided for the Miller and Walker Creeks Basin through the addition of large woody debris and improvements to riparian areas, including invasive plant removal.

Identified projects include:

Additional Estuary Restoration

The PMT supports the estuary restoration work currently being undertaken by the Normandy Park Community Club and should continue to work with the Club to determine if additional estuary restoration could be implemented. Any potential projects would need to be developed with the property owner. Costs would be determined by specific project identified.

Miller Creek 1st Avenue South Culvert

Replacing the Miller Creek culvert under 1st Avenue South would provide fish passage improvements. However, analyses indicates this project could be difficult and costly to implement with costs ranging upward from $1,000,000. Additional study is needed to determine feasibility and compatibility with FAA regulations on hazardous wildlife attractants on and near airports (FAA Advisory Circular #150/5200-33A).

Miller Creek Concrete Weirs

A series of concrete weirs located in Miller Creek downstream of the 1st Avenue South culvert should be removed and the stream bed rehabilitated by adding gravel. Estimated cost is $350,000.

Chapter Six: Next Steps

Before implementation of the recommended projects and programs begins, a number of steps must be taken. These steps range from entering into jurisdictional agreements to securing funding. This chapter presents an overview of next steps for the Miller and Walker Creeks Basin Plan process with a brief discussion of funding and cost sharing issues.

What are the next steps in the process?

In order to implement the recommendations in the Basin Plan, the signatories to the Interlocal Agreement (ILA) will need to take several actions:

1. Adopt the Basin Plan.
2. Agree, through a separate ILA, to enact detention and water quality regulations and provide funding for the projects and programs identified. Discussions concerning the cost shares for the parties to implement the Basin Plan will need to occur prior to creating the ILA. The Port will coordinate with Federal Aviation Administration on use of airport funding for Plan projects.
3. Conduct pre-design and environmental studies to more fully explore the particular engineering challenges that may exist for any given project. Pre-design study will also provide more accurate cost estimates.
4. Purchase or negotiate for properties or easements needed for capital facilities.
5. Complete property acquisitions and final engineering designs.
6. Obtain required permits.
7. Begin and complete construction of capital projects.

Are there any projects which can move forward immediately?

Chapter Four presented a few fairly simple projects and programs which could easily be implemented without extensive discussion, expensive design work, or complex permitting. These projects and programs could include the following:

- hydrologic, water quality and habitat monitoring;
- basin stewardship programs;

- pre-design work and property acquisition for expansion of the Ambaum Detention Pond; and
- modification of the Hermes Depression inlet hoses.

How will recommended projects and programs be funded?

Specific details regarding funding to implement the proposed programs, regulations, and capital facilities will be developed during negotiations among the Basin Plan partners. Methodologies to divide costs equitably among the partners include division of costs based on ownership of land area in the Basin or by impervious area in the Basin. Since the Plan primarily addresses past impacts and impervious surface proportion is the best measure of impact, the PMT has recommended using the impervious methodology only as the most equitable.

Exhibit 6-1 presents potential cost shares using the (effective) impervious area methodology.

Exhibit 6-1
Cost Shares Based on Impervious Area

Jurisdiction	Percent of Total Cost Share
Burien	53%
Port of Seattle	20%
SeaTac	1%
King County	10%
Normandy Park	8%
WSDOT	8%

Are other funding sources available?

In addition to funding provided by the project partners, there may be other funds available to help finance Plan implementation actions. Several are discussed briefly below.

Department of Ecology Water Quality Grants and Loans

Funds are available from the Centennial Clean Water Fund, the federal Clean Water Act Section 319 Nonpoint Source Fund, and the Washington State Water Pollution Control Revolving Fund programs. Applications for funding are reviewed in conjunction with the WRIA 9 Forum.[1] Over $60,000,000 is available statewide in the most current funding cycle.

[1] *The WRIA 9 Forum is a group of 17 local governments within the WRIA 9 jurisdiction.*

U.S. Fish and Wildlife Service Programs

The U.S. Fish and Wildlife Service administers the Western Washington Restoration Programs, which include Partners for Fish and Wildlife, Puget Sound, and Chehalis Fisheries Restoration. Project types include on-the-ground restoration, assessment, and outreach.

National Oceanic and Atmospheric Administration (NOAA) Community-Based Restoration Program

The NOAA Restoration Center's Community-based Restoration Program (CRP) provides funding for locally driven, grass-roots habitat restoration projects that will benefit living marine resources, including anadromous fish. Projects funded through the CRP have strong on-the-ground habitat restoration components that provide educational and social benefits for people and their communities in addition to long-term ecological habitat improvements. Proposed projects must cost between $30,000 and $250,000. Projects are strongly encouraged to provide a non-federal match of at least one-to-one (cash or in-kind).

King County WaterWorks Program

The WaterWorks Program accepts proposals from nonprofit organizations and local governments for community stewardship projects that help further salmon conservation efforts in the WRIA 9 watershed. The maximum award for a project is $60,000 and projects must have a 25 percent cash match. Projects that meet the program criteria and are recommended by the WRIA 9 Forum go through a less competitive review process and therefore have a better chance of being funded.

King Conservation District Grant Funding

The King Conservation District (KCD) awards grants for watershed conservation activities based on recommendations from each of the three Watershed Forums in King County (the Snoqualmie Watershed Forum, the Cedar/Sammamish/Lake Washington (WRIA 8) Forum, and the Green/Duwamish and Central Puget Sound Watershed Forum (WRIA 9). The Miller and Walker Creek watersheds are within the WRIA 9 area. Proposed projects are reviewed on a rolling basis using Forum-developed criteria Projects that the Forum recommends for funding are forwarded for approval to King Conservation District.

References

Batcho, A. Trout Unlimited. Personal communication.

Bilby, R. E., B. R. Fransen, and P. A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences 53:164-173.

Booth, D. B. 2000. Forest cover, impervious-surface area, and the mitigation of urbanization impacts in King County, Washington. Center for Urban Water Resources Management, Seattle, WA, USA. unpublished

Booth, D. B. and P. C. Henshaw. 2002. Rates of channel erosion in small urban streams. p.17-38. In Wigmosta, M. S. and S. J. Burges (eds.) Land Use and Watersheds: Human Influence on Hydrology and Geomorphology in Urban and Forest Areas. Water Science and Application Volume 2. American Geophysical Union, Washington, D.C.

Booth, D. B. and C. R. Jackson. 1994. Urbanization of aquatic systems - degradation thresholds and limits of mitigation. 425-434. Effects of Human-Induced Changes on Hydrologic Systems, Proceedings; Annual Summer Symposium of the American Water Resources Association, Jackson Hole, WY, USA.

Booth, D.B. and C.R. Jackson. 1997. Urbanization of aquatic systems: degradation thresholds, stormwater detention, and the limits of mitigation. Journal of the American Water Resources Association 2003 vol. 13, no. 1, pp. 35-49

Cowardin, L.M. (1979). Classification of wetlands and deepwater habitats of the United States. Washington, D.C., Fish and Wildlife Service.

DOE, 2005. Washington State's Water Quality Assessment, 303(d) & 305(b) Report, Water Quality Listings by Category. http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/wq_assessment_cats2004.html. Accessed September 16, 2005.

Gregory, S.V., G.A. Lamberti, D.C. Erman, K.V. Koski, M.L. Murphy, and J.R. Sedell. 1987. Influence of forest practices on aquatic production. In E.O. Salo and T.W. Cundy (editors) Streamside management: forestry and fishery interactions. Seattle, Institute of Forest Resources, University of Washington.

Hammer, T. R. 1972. Stream channel enlargement due to urbanization. Water Resources Research 8:1530-1540.

Hillman, T. W., J. R. Stevenson, and D. J. Snyder. 1999. Assessment of spawning and habitat in three Puget Sound streams, Washington. Report to the Airport Community Coalition, Des Moines, WA.

Karr, J.R. and E.W. Chu. 1998. Restoring Life in Running Waters: Better Biological Monitoring. Island Press, Washington, DC.

King County, 1987. Program Summary - Basin Reconnaissance Program. Reconnaissance Report No. 12 - Miller Creek Basin.

Kleindl, 1995. A benthic index of biotic integrity for Puget Sound lowland stream, Washington, USA. University of Washington. Masters Thesis

Levy, S. 1997. Pacific salmon bring it all back home. BioScience 47: 657-660.

Luchessa, 1995. Appendix F Sea-Tac airport master plan update final EIS: Stream survey report for Miller Creek. Shapiro and Associates, Inc. Seattle.

Morley, S. A, 2000. Effects of urbanization on the biological integrity of Puget Sound lowland streams: Restoration with a biological focus. University of Washington

NOAA, 2005. Acute die-offs of adult coho salmon returning to spawn in restored urban streams. Northwest Fisheries Science Center. http://www.nwfsc.noaa.gov/research/divisions/ec/ecotox/fishneurobiology/acutedieoffs.cfm. Accessed September 15, 2005

Watershed Professionals Network, 1999. Oregon Watershed Assessment Manual. Watershed Enhancement Board, Salem, Oregon.

Parametrix (2000). Biological Assessment: Master Plan Update Improvements Seattle-Tacoma International Airport. Port of Seattle.

Parametrix (2001). Natural Resource Mitigation Plan, Seattle-Tacoma International Airport, Master Plan Update. Port of Seattle.

Parametrix (2002). Figure 1b wetlands and monitoring wells near the Seattle-Tacoma International Airport third runway embankment.

Roni, P. and T.P. Quinn. 2001. Effects of artificial wood placement on movements of trout and juvenile coho in natural and artificial channels. Transactions of American Fisheries Society 130:675-685.

Roni, P., M. Liermann, and A. Steel. 2002. Monitoring and evaluating responses of salmonids and other fishes to in-stream restoration. In D.R. Montgomery, S. Bolton, and D. B. Booth, (editors), Restoration of Puget Sound Rivers, University of Washington Press.

Roni, P., T.J. Beechie, R.E., Bilby, F.E. Leonetti, M.M. Pollock, and G.P. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management. 22:1-20.

Trout Unlimited. 1993. Miller Creek salmon spawner survey data. Trout Unlimited.

Slaney, P.A., B.R. Ward, and J.C. Wightman. 2003. Experimental nutrient addition to the Keogh River and application to the Salmon River in coastal British Columbia. J.G. Stockner,(editor), Nutrients in salmonid ecosystems: sustaining production and biodiversity, p. 111-126. American Fisheries Society, Symposium 34, Bethesda, Maryland.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki.1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon.)

University of Washington, Department of Landscape Architecture, 1973. Miller Creek Watershed, 70 pp.

Walsh, C. J. 2000. Urban impacts on the ecology of receiving waters: a framework for assessment, conservation and restoration. Hydrobiologia 431:107-114.

Wang, L. Z., J. Lyons and P. Kanehl. 2003. Impacts of urban land cover on trout streams in Wisconsin and Minnesota. Transactions of the American Fisheries Society 132:825-839.

Washington Trout. 2003 Water Type Survey Results, South King County. May/June, 2003. Duvall, Washington.

Washington Trout. (2004). Water Type Survey Results, South King County. May/June, 2003. Duvall, WA, Washington Trout.

Williams, W.R. and Richard M. Laramie, James J. Ames. (1975). A Catalog of Washington Streams. Washington Department of Fisheries.

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Glossary

Alluvial fan

A fan-shaped accumulation of alluvium deposited at the mouth of a ravine or at the juncture of a tributary stream with the main stream

Anadromous fish

Fish that ascend rivers from the sea for breeding

Basin

A geographic area that contains and drains to a stream or river named and noted on common maps, such as the Cedar River, Sammamish River, Green River, Snoqualmie River, Skykomish River, or White River, or a geographic area that drains to a non-flowing water body named and noted on common maps, such as Lake Washington or Puget Sound

Best Management Practices (BMPs)

A schedule of activities, prohibitions of practices, physical structures, maintenance procedures, and other management practices undertaken to reduce or prevent increases in runoff quantity and pollution.

Channel

A long, narrow excavation or surface feature that conveys surface water and is open to the air

Channel, constructed

A channel or ditch constructed to convey surface water; also includes reconstructed natural channels.

Channel, natural

A channel which has occurred naturally due to the flow of surface waters; or a channel that, although originally constructed by human activity, has taken on the appearance of a natural channel including a stable route and biological community

Closed depression

An area which is low-lying and either has no surface water outlet or has such a limited outlet that during storm events the area acts as a retention basin, with more than 5000 square feet of water surface area at overflow elevation

Constructed conveyance system facilities

Gutters, ditches, pipes, channels, and most flow control and water quality treatment facilities

Conveyance System

Drainage facilities and features that collect, contain, and provide for the flow of surface and storm water from the highest points on the land down to a receiving water. Conveyance systems are made up of natural elements and/or of constructed facilities.

Detention

Release of surface and storm water runoff from the site at a slower rate than it is collected by the drainage facility system, the difference being held in temporary storage

Detention facility

A facility that collects water from developed areas and releases it at a slower rate than it enters the collection system. The excess of inflow over outflow is temporarily stored in a pond or a vault and is typically released over a few hours or a few days.

Discharge

Runoff, excluding offsite flows, leaving the proposed development through overland flow, built conveyance systems, or infiltration facilities

Ditch

A constructed channel with its top width less than 10 feet at design flow

Drainage

The collection, conveyance, containment, and/or discharge of surface and storm water runoff

Drainage area or Drainage basin

An area draining to a point of interest

Drainage facility

A constructed or engineered feature that collects, conveys, stores or treats surface and storm water runoff. Drainage facilities shall include but not be limited to all constructed or engineered streams, pipelines, channels, ditches, gutters, lakes, wetlands, closed depressions, flow control or water quality treatment facilities, erosion and sedimentation control facilities, and other drainage structures and appurtenances that provide for drainage.

Embankment

A structure of earth, gravel, or similar material raised to form a pond bank or foundation for a road

Erosion

The detachment and transport of soil or rock fragments by water, wind, ice, etc.

Habitat

The specific area or environment in which a particular type of plant or animal lives and grows

Impervious surface

A hard surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development; and/or a hard surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development.

Common impervious surfaces include, but are not limited to, rooftops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam, or other surfaces which similarly impede the natural infiltration of surface and storm water runoff.

Infiltration

The hydrologic process of water soaking into the ground (commonly referred to as percolation)

Lake

An area permanently inundated by water in excess of two meters (7 feet) deep and greater than twenty acres in size as measured at the ordinary high water mark

Level 1 Flow Control

A stormwater detention facility design standard that matches the peak discharge rates for a proposed development to the existing site conditions peak discharge rates for two- and 10-year return periods. Application of this standard results in a facility that maintains the existing site condition peak discharge rates for stormwater runoff events that have a statistical probability of occurring once every two to 10 years.

Level 2 Flow Control

A stormwater detention facility design standard that matches the peak discharge rates and durations for a proposed development to those generated by a predevelopment site condition prescribed by regulation. The prescribed predevelopment site condition can be that which existed at the time of development (existing site conditions), that which historically (e.g., all forest), or somewhere in between (e.g., 75% forest, 15% grass, 10% impervious surface). Peak discharge rates are matched for two- and 10-year return periods while durations are matched for peak discharge rates ranging from 50% of the two-year rate to the full 50-year rate.

Low Impact Development (LID)

A stormwater management strategy that emphasizes conservation and use of on-site natural features integrated with distributed, decentralized small-scale stormwater management controls to more closely mimic a site's predevelopment hydrology. Low impact development includes the use of best management practices (BMPs) for dispersing, infiltrating, or otherwise reducing or preventing development-related increases in runoff at or near the sources of those increases. LID BMPs include, but are not limited to, preservation and use of native vegetated surfaces to fully disperse runoff; use of other pervious surfaces to disperse runoff; roof downspout infiltration; permeable pavements; rainwater harvesting; vegetated roofs; and reduction of development footprint. The goal of low impact development is to provide mitigation of hydrologic impacts that are not possible/practical to mitigate with a flow control facility. Such impacts include increases in runoff volumes and flashiness and decreases in groundwater recharge. LID BMPs seek to reduce runoff volumes and flashiness and increase groundwater recharge by reducing imperviousness and making use of the pervious portions of development sites to maximize infiltration and retention of stormwater onsite.

Ravine

A small stream channel, narrow and steep-sided in cross section

Reach

A length of channel with uniform characteristics

Retention

The process of collecting and holding surface and storm water runoff with no surface outflow

Riparian

Pertaining to the banks of rivers and streams, and sometimes also wetlands, lakes, or tidewater

Runoff

Water originating from rainfall and other precipitation that ultimately flows into drainage facilities, rivers, streams, springs, seeps, ponds, lakes, and wetlands as well as shallow groundwater

Salmonid

A member of the fish family Salmonidae. In King County salmonid species include Chinook, Coho, chum, sockeye, and pink salmon; cutthroat, rainbow, and brown trout and steelhead; Dolly Varden, brook trout, char, kokanee, and whitefish.

Stormwater

Stormwater is the water from rainfall or other precipitation that runs off surfaces such as rooftops, paved streets, highways, and parking lots. It can also come from hard grassy surfaces like lawns, play fields, and from graveled roads and parking lots.

Stormwater Facility

Facilities that control the discharge of stormwater. Stormwater facilities may also be designed to remove pollutants from stormwater discharges. Types of stormwater facilities may include storage facilities (ponds, vaults, underground tanks, and infiltration systems); water quality facilities (wetponds, biofiltration swales, constructed wetlands, sand filters, and oil/water separators); and conveyance systems (ditches, pipes, and catchbasins).

Stormwater Management

The application of site design principles and construction techniques to prevent sediments and other pollutants from entering surface or ground water; source controls and treatment of runoff to reduce pollution

Swale

A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than one foot

Toxic

Poisonous, carcinogenic, or otherwise directly harmful to life

Upland

An area of high or relatively high ground

Wetland

An area inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (U.S. Army Corps of Engineers Regulation 33 CFR 328.3 (1988))